Claims:

1. A protective coating for use on a surface of an article in a corrosive environment, consisting of:
a polycrystalline diamond film material made by chemical vapor deposition having a thermal conductivity greater than 1000 W/mK and a Raman Full Width at Half Maximum of less than 10 cm^{-1}, said diamond film material having a thickness not greater than 150 microns.

2. A protective coating according to claim 1, wherein:
said diamond film material has a thickness between 5 and 40 microns.

3. A protective coating according to claim 1, wherein:
said diamond film material is transparent to infrared radiation.

4. A protective coating according to claim 1, wherein:
said diamond film material has a Raman Full Width at Half Maximum of less than 5 cm^{-1}.

5. A protective coating according to claim 1, further comprising:
a dopant added to said polycrystalline diamond film material to increase its electrical conductivity.

6. A protective coating according to claim 5, wherein:
said dopant is boron.

7. An apparatus for processing a semiconductor wafer, comprising:

a) a processing chamber having an inner surface; and

b) a mandrel within said chamber and adapted to receive and hold the semiconductor wafer,

at least one of said inner surface and said mandrel including a protective coating comprising a polycrystalline diamond film material made by chemical vapor deposition having a thermal conductivity greater than 1000 W/mK and a Raman Full Width at Half Maximum of less than 10 cm^{-1}, said diamond film material having a thickness not greater than 100 microns.

8. A apparatus according to claim 7, wherein:

said processing chamber includes a heat source and at least one window which is substantially transparent to heat from said heat source, at least a portion of said window being provided with said protective coating.

9. A processing chamber according to claim 7, wherein:

said mandrel is adapted to rotate about an axis within said chamber.

10. A processing chamber according to claim 7, wherein:

said protective coating has a Raman Full Width at Half Maximum of less than 5 cm^{-1}.

11. An electrode, comprising:

a) an electrically conductive body;

b) a polycrystalline diamond film coating on said body, said coating having been made by chemical vapor deposition and having a thermal conductivity greater than 1000 W/mK and a Raman Full Width at Half Maximum of less than 10 cm^{-1}, said diamond coating having a thickness not greater than 40 microns; and

c) a dopant in said diamond coating for increasing its electrical conductivity.

12. An electrode according to claim 11, wherein:

said polycrystalline diamond film has a Raman Full Width at Half Maximum of less than 5 cm^{-1}.

13. A method of growing a thin film diamond coating which resists corrosion and erosion, said method comprising:

a) positioning a substrate element on a deposition mandrel in a processing chamber of a chemical vapor deposition (CVD) system

b) growing a diamond coating on said substrate to a thickness of between 5 and 150 microns, the diamond coating having a Raman Full Width at Half Maximum of less than 10 cm^{-1}, and

c) removing said substrate from said processing chamber.

14. A method according to claim 13, wherein:

said substrate is maintained at a temperature of greater than 700°C.

15. A method according to claim 13, wherein:

said diamond coating is grown at a rate of between 0.5 and 6.0 microns per hour.

16. A method according to claim 13, wherein:

said diamond coating has a thermal conductivity greater than 1000 W/mK.

17. A method according to claim 13, wherein:

said diamond coating has a Raman Full Width at Half Maximum of less than 10 cm^{-1}.

18. A method according to claim 13, wherein:

said diamond coating has a Raman Full Width at Half Maximum of less than 5 cm^{-1}.